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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER

NGUYEN, HA T

ART UNIT

PAPER NUMBER

2812

DATE MAILED: 01/17/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Applicant(s)

09/653,561

Applicant(s)

HILLYER ET AL.

Examiner

Ha T. Nguyen

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-53 is/are pending in the application.
- 4a) Of the above claim(s) 45-49 is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-44 and 50-53 is/are rejected.
- 7) ☐ Claim(s) ____ is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 31 August 2000 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on ____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. ____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☒ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 2.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). ____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

DETAILED ACTION

Notice to applicant

1. Applicants' election of Group I, claims 1-44 and 50-53 without traverse has been entered and made of record (Paper No. 4).

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action.

A person shall be entitled to a patent unless --

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371[©] of this title before the invention thereof by the applicant for patent.

3. Claims 1 and 2 are rejected under 35 U.S.C. 102(e) as being anticipated by Vaartstra, U. S. Patent 6242165.

Referring to Fig. 1, Vaartstra discloses a method for removing polymer etch residue from an etched opening 18 in a silicon wafer device 12 comprising contacting said opening with ammonia gas to remove said polymer etch residue (see abstract, col. 3, lines 17-24, and col. 4, Lines 30-57); wherein said opening is a HAR contact opening (see col. 7, lines 12-31).

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to

the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103[®] and potential 35 U.S.C. 102(f) or (g) prior art under 35 U.S.C. 103(a).

5. Claims 1-15, 25, and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hopper et al. , U. S. Patent 6030901 (hereinafter Hopper).

[Claim 1] Referring to Fig. 1, Hopper discloses a method for removing a photoresist mask used for etching an opening 14 in a semiconductor wafer device comprising: contacting the device including said opening with ammonia gas to remove the photoresist mask and inherently remove, from the etched opening, a polymer etch residue deposited on the opening during the opening etching (see abstract, col. 1, lines 6-12, and paragraph bridging cols. 4 and 5), the examiner interprets that the combined nitrogen and hydrogen gas plasma is equivalent to ammonia gas plasma because they contain the same species ;

[Claim 2] wherein said opening is a HAR contact opening (see col. 1, lines 14-22);

[Claim 3] wherein said contacting is performed under conditions effective to remove said etch residue without substantially increasing the size of said opening (See col. 4, lines 35-49);

[Claim 4] wherein said opening is contacted with ammonia gas in the absence of oxygen (See col. 4, lines 50-63);

[Claim 5] wherein said ammonia gas is in a plasma (See col. 4, lines 34-49); and

[Claim 6] wherein said contacting is done at a temperature within the range of about 250-500C (See col. 4, lines 50-63);

[Claim 14] further comprising forming a conductive layer at the bottom of said opening following said contacting step (see paragraph bridging cols. 5 and 6);

But it does not disclose expressly that the semiconductor wafer is a silicon wafer, that all the above features are in the same embodiment and the details about the parameters concerning flow rate, contacting time and power used.

However, the missing limitations are well known in the art because the most commonly used semiconductor material for making semiconductor device is silicon, and the above

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generally described features are not limited to a specific embodiment but can be used in a specific application to achieve the desired characteristics. Hopper does not disclose the details about the parameters concerning flow rate, contacting time and power used.

However any variation in flow rate, contacting time, and power used in the present claims is obvious in light of the cited art, because the changes in flow rate, contacting time, and power used produce no unexpected function.

The routine varying of parameters to produce expected changes are within the ability of one of ordinary skill in the art. Patentability over the prior art will only occur if the parameter variation produces an unexpected result. In re Aller, Lacey and Hall, 105 U.S.P.Q. 233, 235. In re Reese 129 U.S.P.Q. 402, 406.

As to claims 15, 25, and 26, Hopper discloses substantially the limitations of claims 15, 25, and 26 as shown above.

But it does not disclose expressly that wherein said contacting step produces silicon nitride at the bottom of said opening, said method further comprising removing said silicon nitride and wherein said bottom of said opening is not oxidized during said ammonia contacting step.

However, it is well known in the art that both metal and doped polysilicon are conductive material commonly used for interconnection, in the case where the interconnect 11 is of doped silicon, silicon nitride will be formed because of the exposure of polysilicon to excited nitrogen species and it would have been obvious that the removing of silicon nitride is required to improve connection conductivity.

Therefore, it would have been obvious to use Hopper's teaching to obtain the invention as specified in claims 1-15, 25, and 26.

6. Claims 16-24, 27, and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kawai, US Patent 6284664 in view of Hopper.

Kawai discloses a method for removing polymer etch residue from an etched opening in a silicon wafer device, comprising the steps of: contacting said opening with an oxygen containing plasma (See col. 4, lines 45-58).

But it does not disclose expressly the stopping of oxygen plasma contacting before said polymer etch residue is completely removed and thereafter contacting said opening with ammonia gas, and the details about the parameters concerning flow rate, power, and contact duration.

However, the missing limitations are well known in the art because Hopper discloses the etching of photoresist material using a plasma of a mixture of hydrogen and nitrogen gases, considered equivalent to ammonia (See abstract). Oxygen plasma etching is more commonly used to remove organic material, but the plasma of a mixture of hydrogen and nitrogen gases can remove the residue more effectively therefore it is preferred to be used at the end of the cleaning step. Hopper also discloses the limitations of claims 17-20, as shown above. Arguments concerning the parameters of flow rate, power, and contact duration stated above also apply.

A person of ordinary skill is motivated to modify Kawai with Hopper to obtain more effective organic material cleaning .

Therefore, it would have been obvious to combine Kawai with Hopper to obtain the invention as specified in claims 16-24, 27, and 28 .

7. Claims 29 and 41-44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kawai in view of Vaartstra.

[Claim 29] Referring to Figs. 3A-3D, Kawai discloses a method of forming a contact opening in a semiconductor device, comprising: etching a contact opening 22 in an insulative layer 18 in said device down to a polysilicon¹⁴ element of said device; and cleaning etch residue from said etched opening by contacting said opening with a gas (see col. 4, lines 4-58);

[Claim 41] wherein an insulating layer 18 is formed on said device prior to said etching and said etching forms a contact hole in said insulating layer;

[Claims 42-44] wherein in said etching is dry etching; wherein said dry etching is performed using at least one fluorine containing gas; and wherein said fluorine-containing gas is at least one gas selected from the group consisting of CH_2F_2 , CHF_3 , C_2F_6 , C_2HF_5 , and CH_3F (see col. 4, lines 8-18).

But it does not disclose expressly the use of ammonia gas for cleaning etch residue .

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However, it is well known in the art because Vaartstra discloses this feature (See abstract).

A person of ordinary skill is motivated to modify Kawai with Vaartstra to obtain a more effective polymer residue cleaning etch.

Therefore, it would have been obvious to combine Kawai with Vaartstra to obtain the invention as specified in claims 29 and 41-44 .

8. Claims 30-38 and 40 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kawai in view of Vaartstra, as applied to claims 29 and 41-44 above, and further in view of Hopper.

The combined teaching of Kawai and Vaartstra disclose substantially the limitation of claims 30-38 and 40.

But it does not discloses the details about the details concerning cleaning conditions and parameters concerning flow rate, power, and contact duration.

However, the missing limitations are well known in the art because Hopper discloses the etching of photoresist material using a plasma of a mixture of hydrogen and nitrogen gases, considered equivalent to ammonia (See abstract). Oxygen plasma etching is more commonly used, but the plasma of a mixture of hydrogen and nitrogen gases can remove the residue more effectively therefore it is preferred to be used at the end of the cleaning step. Hopper also discloses the limitations of claims 30-33, as shown above. Arguments concerning the parameters of flow rate, power, and contact duration stated above also apply.

Therefore, it would have been obvious to combine Kawai and Vaartstra with Hopper to obtain the invention as specified in claims 30-38 and 40.

9. Claim 39 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kawai in view of Vaartstra, and further in view of Hamada, US Patent 6291890.

The combined teaching of Kawai and Vaartstra discloses substantially the limitations of claim 39, as shown above.

But it does not discloses that the step of forming a silicide layer at the bottom of said contact opening.

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However, the missing limitation is well known in the art because Hamada discloses forming a titanium silicide 111 at the bottom of said opening.

A person of ordinary skill is motivated to modify Kawai and Vaartstra with Hamada to obtain improved connection conductivity.

Therefore, it would have been obvious to combine Kawai and Vaartstra with Hamada to obtain the invention as specified in claim 39 .

10. Claims 50-53 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kawai in view of Hopper and Hamada.

[Claim 50] Referring to Figs. 3A-3D, Kawai discloses a method of forming an integrated circuit structure comprising: forming an insulating layer 18 over a polysilicon region 14; forming a contact opening in said insulating layer down to said polysilicon region using a fluorine containing gas (see col. 4, lines 4-18); removing polymer residue from said contact opening using a gas (see col. 4, lines 26-58);

[Claim 52] further comprising removing a portion of said polymer residue from said contact opening with oxygen;

But it does not disclose that the contact opening has HAR, the steps of removing polymer residue with ammonia gas, forming a titanium silicide at the bottom of said opening in contact with said polysilicon layer; forming a conductor in said opening in electrical contact with said silicide; and using said gas to remove polymer residue after using oxygen plasma.

However, the missing limitations are well known in the art because Hopper discloses the etching of polymeric material using a plasma of a mixture of hydrogen and nitrogen gases considered equivalent to ammonia gas (see abstract) to clean a substrate and inherently a contact opening; and Hamada discloses forming a titanium silicide 111 at the bottom of said opening in contact with said polysilicon layer 104; forming a conductor 112 in said opening in electrical contact with said silicide (see Fig. 3D and col. 5, lines 1-20).

The combined teaching does not expressly disclose the etching of the polymer residue using oxygen prior to ammonia. However it would have been obvious because Oxygen plasma

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etching is more commonly used, but the plasma of a mixture of hydrogen and nitrogen gases can remove the residue more effectively therefore it is preferred to be used at the end of the cleaning step.

A person of ordinary skill is motivated to modify Kawai with Hopper and Hamada to obtain good cleaning and improved connection conductivity.

Therefore, it would have been obvious to combine Kawai with Hopper and Hamada to obtain the invention as specified in claims 50-53 .

Conclusion

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ha Nguyen whose telephone number is (703)308-2706 . The examiner can normally be reached on Monday-Friday from 8:30AM to 5:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John Neibling, can be reached on (703) 308-3325. The fax phone number for this Group is (703) 308-7722.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956.

Primary Examiner



Ha Nguyen

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